Step 4: **Management Solutions**

Introduction

The goal of the Management Solutions step is to create a watershed management plan to address the issues identified during Scoping, Watershed Assessment, and Synthesis. The management plan should describe multiple management solutions to provide flexibility in the implementation of watershed improvements (Box 1).

Management solutions for addressing watershed issues or problems can take many forms:

- Changes in land use (e.g., land use planning or zoning).
- Changes in management practices (e.g., Best Management Practices [BMPs]).
- Monitoring programs.
- Educational programs.
- Restoration plans.
- Regulatory changes (e.g., water quality standards and criteria).

The type of management solutions developed through the WAM process will depend largely on the scale and level of assessment. A Level 1 assessment provides a general characterization of the watershed that may be useful for land use planning, identifying monitoring needs, or developing educational programs. This level of information is typically not detailed enough to evaluate or suggest specific prescriptive actions. A Level 2 assessment can provide more site-specific information that can be used to evaluate the effectiveness of management practices, identify restoration opportunities, or establish resource-based water quality standards.

Box 1. Watershed management planning in Nantucket, Massachusetts

In response to a variety of threats to Nantucket's water supply, the Nantucket Land Council, a private, non-profit organization, commissioned the development of a water resource management plan. Twelve water resource protection areas were delineated as part of the plan and designated for priority protection. Among these areas were wellhead protection areas for the island's two principal public water supply wells, a larger aquifer protection area designated as a source of future water supplies, and the drainage areas for coastal and freshwater ponds. The designated areas were protected by a combination of regulatory and non-regulatory measures, including zoning districts that regulated land use, subdivision and wetlands regulations, on-going water quality monitoring, and public education campaigns discussing the residential use of lawn fertilizer and household chemicals.

Adapted from EPA (1995a)

Using information generated during the previous steps, the WAM approach can provide a strong link between community values, scientific information, and the development of

practical and effective management solutions. Information from these steps is used to identify resource needs, the effects of current and past management, and the success or failure of past practices. With broad community participation and support, the technical information can be used to suggest effective management changes to protect and enhance the valued resources identified during the Scoping process.

Watershed management plans should be integrated with existing programs and tailored to the needs of the community and the unique character of the watershed. Ideally, multiple programs and solutions will be developed as part of the management plan to provide flexibility in the implementation of watershed improvements. Existing projects and programs such as water quality monitoring or stream restoration should be considered elements of a comprehensive watershed approach to management solutions.

This section describes the steps to develop a watershed management plan. Examples of management objectives and solutions are provided. Information on watershed restoration is described, and possible sources of funding are identified. Information on developing monitoring programs can be found in the next section, Adaptive Management.

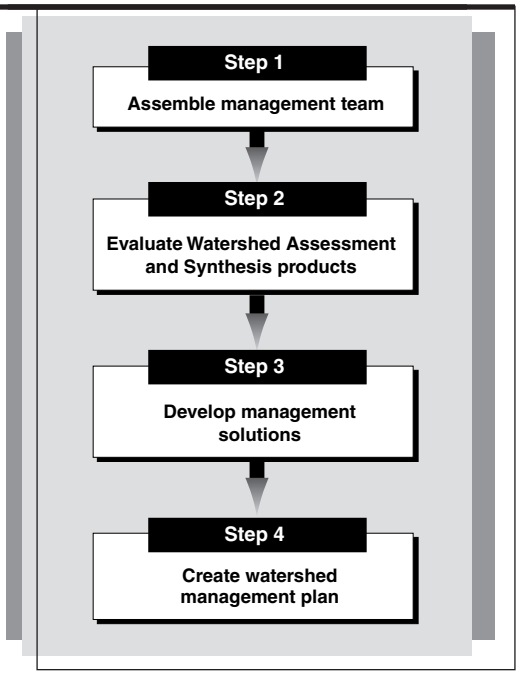
Management Solutions Process

Step Chart

Procedure

The objectives of the Management Solutions step are as follows:

- To use information from previous steps to develop management objectives and options.
- To create a watershed management plan.
- To develop incentives for implementation of management solutions.



Step 1. Assemble management team

The management team will be responsible for setting management objectives and developing a set of prioritized options for each objective. Deciding who will participate on the management team depends upon the number of people involved in the WAM process. If a small number of people are involved, it may be possible to include all participants in the management team. Otherwise, a cross-section of community leaders and technical staff should be included on the management team. If effective changes are expected from this process, it is vital to include representatives from all interested parties who might be affected by the proposed management changes.

A combination of people with technical and policy backgrounds in environmental resource management is ideal to identify and evaluate options for changes in management practices and watershed programs. At least a few individuals who participated in the Watershed Assessment can be a part of the management team to provide background information and help resolve technical questions. Land owners, industry representatives, and regulatory agencies may also be integral for developing effective management solutions.

Step 2. Evaluate Watershed Assessment and Synthesis products

Before management objectives and solutions can be written, it is important to understand the results of the Watershed Assessment and the summaries of watershed issues that were produced in Synthesis (Form S1). The summaries of watershed issues may provide sufficient detail for establishing objectives and solutions, but often a more comprehensive understanding of watershed issues is necessary. If the management team is identified ahead of time, it may be helpful for members to attend the Synthesis meetings. Another option is for the assessment team to provide a summary presentation to the management team. A field review of the watershed or specific areas of concern may also be warranted to provide further information for developing effective management solutions.

Step 3. Develop management solutions

The summaries of watershed issues (Form S1) from Synthesis provide a list of watershed concerns that may require specific management solutions. The team should develop a management objective for each issue. A set of specific solutions can then be written

to address each objective. Multiple options are encouraged for each objective to provide flexibility for implementation by community members (Box 2). The objectives and solutions should be recorded on Form M1 (Figure 1). The rationale for each solution should also be recorded for future reference. Rationale may be based on local data, technical and management expertise, or scientific literature.

Box 2. Management planning in the Klamath River basin, Oregon

Physical obstructions, habitat destruction, and pollutants have severely degraded an important tribal and commercial salmon and trout fishery in the Klamath River, Oregon. The long-range restoration plan was developed using a sequence of goals, objectives, policies, and priority projects. Examples of goals, objectives, and policies from this program are provided below.

Goal: Restore by 2006 the biological productivity of the basin in order to provide for viable commercial and recreational ocean fisheries and in-river tribal and recreational fisheries.

Objective: Protect stream and riparian habitat from potential damage caused by timber harvesting and related activities.

Policies:

- Improve timber harvest practices through local workshops; develop habitat protection and management standards for agency endorsement; and create a fish habitat database.
- Evaluate current timber harvest practices by developing an index of habitat integrity; incorporating fish habitat and population data into state water quality assessments; and monitoring recovery of habitat in logged watersheds.
- Promote necessary changes in regulations, including state forest practice rules, USFS policies in land management plans, and BMPs.
- Anticipate potential problems by requesting additional state monitoring programs; modifying state and federal rules to protect erodible soils; and giving priority to protection of unimpaired salmon habitat.

Adapted from Klamath River Basin Fisheries Task Force (1991)

Figure 1. Sample Form M1. Summary of management options

Issue	Management Objective	Management Solutions	Cost Estimate	Rationale
Erosion from gravel roads	Minimize delivery of eroded sediment to streams	1. Install additional culverts. 2. Grass-seed road cut and fill slopes. 3. Voluntary traffic management plan.	1. $20,000 2. $5,000 3. $1,000	Past use of road improvement plans has been effective at substantially reducing sediment delivery to streams.
Untreated wastewater delivery to the Massassaqua River	Minimize delivery of dairy farm waste to streams during floods	1. Create additional waste storage ponds. 2. Relocate waste storage ponds outside of 100-year floodplain. 3. Establish vegetated biofiltration drainage features.	1. $200,000 2. $75,000 3. $20,000	The watershed assessment identified the close proximity of waste storage facilities to streams as the primary factor causing elevated fecal coliform levels in the river.
Protection of unique natural areas for recreation and wildlife habitat	Restore natural prairie and riparian vegetation communities	1. Initiate educational program on value of riparian buffers. 2. Establish pilot projects for vegetation restoration. 3. Develop conservation easements with private landowners.	1. $5,000 2. $35,000 3. $100,000	The watershed assessment indicated that natural prairie and riparian communities could be re-established through the use of buffers and restoration techniques.
Pollutants in drinking water	Identify trends in drinking water quality	1. Expand existing water quality monitoring program with three additional stations. 2. Conduct statistical analysis and produce a summary report for water quality data from past 10 years of monitoring.	1. $12,000 2. $10,000	Water quality data have been collected at a few locations, but no summary or evaluation of trends has been completed.

Land management options

Table 1 provides examples of management objectives and options to minimize aquatic impact from various land uses. The key to effective aquatic resource protection often is to use several types of aquatic management practices in concert with education and, as necessary, regulation (EPA 1995a). A single type of management practice is seldom sufficient to solve watershed-scale problems. A number of sources are available that provide ideas and guidance on the use of various management solutions:

- Agriculture
  - EPA (1984) describes the factors and available research relevant to selecting appropriate pesticide BMPs.
  - The National Agricultural Library (***http://warp.nal.usda.gov***) offers a bibliography of over 300 citations on evaluation of agricultural BMPs from the AGRICOLA database. The NRCS also provides the National Handbook of Conservation Practices (***http://www.nrcs.usda.gov***) to provide established standards for commonly used practices to protect natural resources.
  - Local NRCS offices often have Field Office Technical Guides at the county level for watershed-specific information.
- Urban
  - Metropolitan Washington Council of Governments (1990) lists non-point source control techniques for urban areas.
  - EPA (1994) describes institutional strategies for developing, revising, and implementing runoff control programs in urbanized communities.
  - EPA (1990) provides information on targeting and prioritizing BMPs in urban areas.
- Forestry
  - EPA (1993a, 1993b) provide a synopsis of BMPs used to mitigate impacts on water quality caused by forestry operations.
- Wetlands
  - EPA (1996) is a guide to stormwater BMPs for protecting wetlands in urban areas, but many practices would also be applicable in other settings.
- Coastal Waters
  - EPA (1992a) describes appropriate management measures and management practices for each major category of non-point source pollution (agriculture, forestry, urban, etc.).

Table 1. Examples of management options and solutions

Land Use Issue	Management Objectives	Management Options
Confined Animal Facilities (small units)	• Design and implement systems that collect solids, reduce contaminant concentrations, and reduce runoff to minimize delivery of pollutants. • Reduce groundwater pollutant loading. • Manage stored runoff and accumulated solids through an appropriate waste utilization system.	• Waste storage ponds • Waste storage structure • Waste treatment lagoons • Filter strips • Grassed waterways • Constructed wetlands • Dikes • Diversions • Heavy use area protection • Lined waterways/outlets • Roof management systems • Terraces • Composting facilities
Forestry	• Establish Streamside Management Areas (SMAs) along surface waters with appropriate widths and harvest restrictions to: 1. maintain a natural temperature regime; 2. provide bank stability; 3. minimize delivery of sediments and nutrients to streams; 4. provide trees for a sustainable source of large woody debris needed for channel structure and aquatic species habitat; and 5. minimize wind damage. • Specify BMPs to minimize erosion. • Develop Road Management Plans.	• SMAs can vary greatly in width depending on site-specific factors (e.g., slope, class of watercourse, type of soil and vegetation, and practice). • Minimize disturbance in SMA from heavy machinery that could expose the mineral soil of the forest floor. • Locate landings, sawmills, and roads outside the SMA. • Establish buffers for pesticide and fertilizer application to limit entry into surface waters. • Prevent excessive amounts of slash and small organic debris from entering the waterbody. • Apply harvesting restrictions in the SMA to maintain its integrity.
Agricultural Land	• Minimize the delivery of sediment from agricultural lands to surface waters. • Design and implement a combination of management practices to settle fine-grained solids and associated pollutants to minimize delivery to streams.	• Conservation cover on land retired from production • Conservation cropping sequence • Conservation tillage • Contour farming • Cover and green manure crop • Plantings on erodible or eroding areas • Leave crop residue to provide protection from erosion • Delayed seed bed preparation • Field border or other filter strip • Grassed waterways • Grasses and legumes in rotation • Sediment basins • Field strip-cropping • Terracing • Wetland and riparian zone protection

Adapted from EPA (1992a)

Restoration approaches

Understanding the relationships among physical, chemical, and biological watershed processes is critical for determining where and what type of habitat restoration will be effective for improving stream quality and supporting valued resources. Since most restoration projects are relatively expensive, the longevity and cost-effectiveness of the project must be objectively evaluated.

Stream restoration can be categorized by three general approaches (EPA 1995b):

1. Upland techniques generally involve BMPs that control non-point source inputs from the watershed (e.g., erosion and runoff control, reforestation, restoration of native plant communities, wetland restoration).

2. Riparian techniques are applied out of the channel in the riparian corridor (e.g., reestablishment of vegetative canopy, increasing width of riparian corridor, restrictive fencing).

3. In-stream techniques are applied directly in the stream channel (e.g., channel realignment to restore geometry, meander pattern, substrate composition, structural complexity, or streambank stability).

In-stream restoration practices often need to be accompanied by techniques in the riparian area and the surrounding watershed. For example, restoring a stream may not only involve reconfiguring the channel form and stabilizing stream banks but can also require planting riparian vegetation and controlling excess sediment and chemical loading in the watershed. Details about specific restoration practices are beyond the scope of this guide; however, Table 2 provides examples of techniques relevant to various watershed issues.

The following sources provide further information on restoration strategies and techniques:

- Streams
  - *The Restoration of Rivers and Streams: Theories and Experience* (Gore 1985).
  - *Better Trout Habitat: A Guide to Stream Restoration and Management* (Hunter 1991).
  - *A Classification of Natural Rivers* (Rosgen 1994).
  - *Ecological Restoration: A Tool to Manage Stream Quality* (EPA 1995b).

Table 2. Examples of restoration techniques for various watershed issues

Watershed Issue	Restoration Technique
Altered Stream Morphology	• In-stream structures (e.g., logs, boulders) • Bank protection • Promote riparian vegetation growth
Sedimentation	• Reduce sediment delivery • Restore wetlands • Stabilize banks • Modify operations of water diversion structures
High Streamflows	• Restore natural stream meanders and complexity • Increase substrate roughness • Promote riparian vegetation growth • Restore wetlands • Reduce impervious area
Low Streamflows	• Reduce water withdrawals • Restore native riparian vegetation • In-stream structures (e.g., logs, boulders) • Increase channel depth with machinery • Stabilize banks • Reduce sediment delivery • Restore native riparian vegetation
Biological Integrity	• In-stream structures (e.g., logs, boulders) • Remove passage barriers (e.g., diversions, culverts) • Reduce sediment delivery • Dredging
Toxicity	• Capping material • Restore wetlands for filtering • Promote riparian vegetation growth
Water Temperature	• In-stream structures (e.g., logs, boulders) • Reduce water withdrawals

- Riparian Corridors
  - *Stream Corridor Restoration: Principles, Processes and Practices* (Federal Interagency Stream Restoration Working Group 1998).
  - *A Citizen's Streambank Restoration Handbook* (Izaak Walton League 1995).
- Wetlands
  - *Restoration of Aquatic Ecosystems* (Brooks et al. 1992).
  - *Wetland Creation and Restoration: The Status of the Science* (Kusler and Kentula 1990).

Step 4. Create watershed management plan

Unless the watershed group is small, the management options detailed in Form M1 will generally require review and prioritization by a group of community members larger than the management team alone. This group, often the same people involved in the Scoping step, will need to evaluate management options to ensure that they have community support and the appropriate resources to be implemented. The approved management solutions will be incorporated into a final watershed management plan that prioritizes watershed actions over the next 10 to 20 years (Box 3).

Box 3. Key elements of a watershed management plan

- Clearly defined management objectives
- Range of management options
- Prioritization of management solutions
- Description of rationale and uncertainties
- Cost estimates and funding mechanisms
- Schedule for implementation and completion

The watershed management plan should relate directly to the strategy developed in the Scoping process. The watershed management plan typically involves more specific actions than the strategy developed in Scoping but should be consistent with the WAM goals. In some cases, the watershed management plan may actually become the new watershed strategy.

Prioritizing management actions can be based on any combination of criteria, including the following:

- Expected benefit to resources.
- Geographical importance.
- Critical or unique areas.
- Potential threat to resources.
- Financial impact.
- Community support.

Integrating the scientifically-based watershed priorities with community priorities is one of the biggest challenges of the WAM process. Management options may be prioritized initially based on the technical merits of the proposal, but community values may lead to different priorities. Gaining community support to conduct projects in the highest priority areas may require initially working in biologically less important areas. Projects that engage local community support can then be used to educate the community about working in higher priority areas even if the project is not in close proximity. Working in

a lower priority area may also serve as a pilot project to help learn about potential issues and problems that could arise on a bigger and higher priority project.

Along with the prioritized management solutions, the watershed management plan should include the rationale for choosing priorities or projects. A schedule for the implementation and completion of management actions is also an important component of the plan. Finally, the watershed management plan should be clearly summarized so that the community can easily understand the rationale and outcomes of implementing the plan.

Incentives for implementation

It may be difficult to reach consensus on some management solutions. Management solutions may benefit society as a whole but may not provide an economic benefit to the individual or organization responsible for implementing them. The limited understanding of ecosystems may lead to uncertainties about the results of the assessment. Community members may also disagree about the risk to important resources posed by management practices. Some may argue for the least costly methods, others for the most effective methods, regardless of cost. It will be important to consider incentives for participation and voluntary, rather than regulatory, implementation of BMPs (Box 4). Table 3 summarizes potential incentives to consider in a watershed management plan.

Box 4. Cooperation and incentives in a community context

Most discussions of land management activities will involve personal communication with a land manager, private landowner, or government representative. Cooperative projects, cost-share programs, and technical assistance will probably be the most commonly used incentives. Community meetings and discussions will generally be more productive than will regulatory mechanisms for achieving watershed recovery.

The White Mountain Apache Tribe in Arizona was able to educate local ranchers about the need to protect springs and streams important to the tribe. The tribe hired members of the local livestock association to construct fencing around restoration areas. The investment of time and money by local community members will help to ensure the long-term success of these projects.

Table 3. Incentives for implementing management solutions

Type of Incentive or Motivational Factor	Description of Key Factors
Education	Programs that target and tailor the message to key audiences are most effective in causing change. Technical education about operation and benefits of controls may be necessary.
Technical assistance	Through one-on-one interaction with landowners, the professional staff can recommend appropriate BMPs for various sites. Assistance with on-site engineering or agronomic work may be needed during the implementation of management solutions.
Tax advantages	Federal, state, or local taxing authorities can make changes to reward individuals who implement management solutions.
Cost sharing	Direct payment to individuals who implement management solutions has been effective where the cost-share rate is high enough to elicit widespread participation.
Regulatory incentives	A regulatory system can be established that conditions the receipt of benefits on meeting certain requirements or goals.
Direct purchase of sensitive or problem areas	The purchase of land for preservation, such as community-owned greenbelts or critical wildlife habitat, can be managed by groups such as the Nature Conservancy. Costs are generally high, but direct purchase provides effective protection.
Non-regulatory site inspections	A site visit by staff of local or state agencies can be educational and provide an incentive for voluntary implementation of management solutions.
Community pressure	If a community values the use of certain management solutions, land owners and managers are more likely to implement them.
Direct regulation of land use activities	Regulatory programs that are simple, direct, and easy to enforce are quite effective. Such programs can regulate land use (through zoning ordinances) or the kind and extent of activity allowed (e.g., pesticide application rates), or they can set performance standards for a land activity (such as retention of the first inch of runoff from urban property).

Adapted from EPA (1995a)

Funding

Funding is usually the greatest limitation to watershed management improvements, but well-organized plans using the WAM approach should be eligible for many types of private and public grants. With a little effort, sources of money can be pooled to implement a watershed management plan. The following references are helpful for procuring funds:

- EPA (1999) presents information on 52 federal funding sources (grants and loans) that may be used to fund a variety of watershed protection projects. The information on funding sources is organized into categories, including coastal waters, conservation, economic development, education, environmental justice, fisheries, forestry, Indian tribes, mining, pollution prevention, and wetlands.

- EPA (1992b) describes particularly effective state and local non-point source programs and methods used to fund them.

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Form M1. Summary of management options

Issue	Management Objective	Management Solutions	Cost Estimate	Rationale